

## Case report

## An unusual case of random fire-setting behavior associated with lacunar stroke

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## ABSTRACT

A case of a 47-year-old man with a sudden onset of a bizarre and random fire-setting behavior is reported. The man, who had been arrested on felony arson charges, complained of difficulties concentrating and of recent memory impairment. Axial T1-weighted magnetic resonance imaging showed a low intensity lacunar lesion in the genu and anterior limb of the left internal capsule. A neuropsychological test battery revealed lower than normal scores for executive functions, attention and memory, consistent with frontal lobe dysfunction. The recent onset of fire-setting behavior and the chronic nature of the lacunar lesion, together with an unremarkable performance on tests measuring executive functions two years prior, suggested a causal relationship between this organic brain lesion and the fire-setting behavior. The present case describes a rare and as yet unreported association between random impulse-driven fire-setting behavior and damage to the left internal capsule and suggests a disconnection of frontal lobe structures as a possible pathogenic mechanism.

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## 1. Introduction

The association between fire-setting behavior and psychiatric or medical disorders remains poorly understood. Thus far, studies on the characteristics of fire-setters have revealed associations with substance use disorders, personality disorders, mental retardation, schizophrenia-, mood- and neurotic-spectrum disorders, and impulse-control disorders, including pyromania [1]. Rare associations of fire-setting behavior with sexual disorders, e.g. paraphilic, luteal phase dysphoric disorder, Asperger's syndrome, delirious states, dementia, epilepsy, Klinefelter syndrome, XYY karyotype, Kleine–Levin syndrome, Fahr disease, and mutations in the gene encoding for monoamine oxidase A, have been reported [1–5]. Although a link between fire-setting behavior and various organic brain disorders has been established [6], associations between fire-setting and focal brain lesions have not yet been reported. Here, we describe the case of a 47-year-old first time arsonist who suffered a single lacunar stroke prior to the onset of a bizarre and random fire-setting behavior.

## 2. Case report

A 47-year-old right-handed Caucasian man with a ninth-grade education was referred to us by the Prosecutor's Office for pre-trial

evaluation. The suspect had been arrested on felony arson charges after starting at least ten separate fires in residential neighborhoods in less than a month. The suspect, who had no prior arrests, indictments or convictions, confessed to setting fire indiscriminately and seemingly without purpose to cardboards, newspapers, dustbins, refuse containers and wooden pallets near goods stations, restaurants and private residences. Pre-trial evaluation involved the assessment of (i) the examinee's current mental state, (ii) the examinee's criminal responsibility, primarily depending on the examinee's mental state at the time of the offence, (iii) the examinee's risk for criminal recidivism, and (iv) the suitability of a court order for mental health treatment to reduce criminal recidivism.

Upon presentation, the examinee appeared to feel well but complained of difficulties concentrating and of a recent impairment in memory. He claimed to have had no intent to violate the law and appeared to have no explanation for his fire-setting behavior. He recalled waking up in the early morning hours and leaving his home to roam the streets of his residential neighborhood. He also recalled feeling somehow strange before setting fire to various items haphazardly. The examinee denied any sexual fantasies or arousal associated with the fire-setting.

## 2.1. Medical history

The examinee was taking no regular medication but had a history of alcohol abuse since his adolescent years. Alcohol intoxication was therefore considered as a possible cause for the fire-setting behavior but was later dismissed as no evidence for recent alcohol consumption emerged.

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## 2.2. Mental status examination

Initial multiaxial diagnostic assessment according to classification provided by the Fourth Edition of the Diagnostic and Statistical Manual of Mental Disorders – Text Revision (DSM IV-TR, American Psychiatric Association, Washington DC, 2000) revealed no signs of other axis I disorders. In particular, none of the diagnostic criteria for pyromania were met. There was no evidence for delusions, hallucinations, manic episodes or possible axis II disorders relevant to the fire-setting behavior, e.g. antisocial behavior or mental retardation. Axis III evaluation revealed a history of both hypertension and insulin-independent diabetes mellitus, which raised the possibility of a delirious state as a possible cause for the observed fire-setting behavior [4]. However, this possibility was later also dismissed since previously detected hyperglycemic states appeared to be connected entirely to the examinee's past alcohol use, which he successfully quit two years prior. Axis IV evaluation revealed burdening psychosocial and environmental factors including occupational and housing problems. Upon a search of the examinee's home, investigators were confronted with extreme domestic squalor, although there were no signs of hoarding behavior. Further investigations showed that, prior to the fire-setting, the examinee had been temporarily assigned a solitary custodial job at his workplace, mostly on account of his neglected self-care. Finally, axis V assessment of global functioning revealed a score below 60 (maximum score 100).

## 2.3. Laboratory data

Laboratory results were normal or borderline pathologic and in agreement with the observed self-neglect and malnutrition. A diminished lymphocyte count (990/ $\mu$ l), a slightly elevated C-reactive protein (9 mg/l) and marginally diminished  $\text{Na}^+$  (133 mM) and folic acid levels (2.3  $\mu$ g/l) were found. Serologic testing showed no evidence for infection with *treponema pallidum*, *borrelia burgdorferi*, hepatitis B or C viruses, or HIV 1/2.

## 2.4. Neuroimaging data

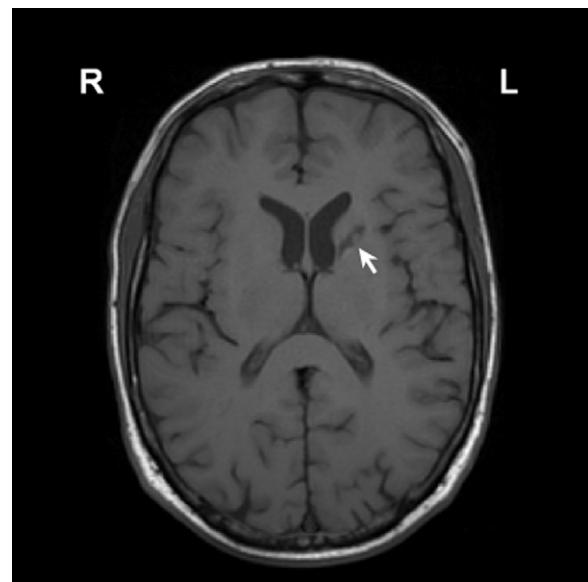
Cerebral magnetic resonance imaging (MRI), however, revealed a lacunar infarction of the genu and anterior limb of the left internal capsule (Fig. 1), involving part of the putamen, that was consistent with an occlusion of a single deep perforating artery [7]. Prophylactic treatment with 100 mg acetylsalicylate daily was begun. The lesion appeared to be chronic, implying that the hemorrhage had occurred prior to the recent fire-setting spree.

## 2.5. Neurologic examination

Apart from hyperactive muscle stretch reflexes of the right arm, consistent with a lesion of the genu of the left internal capsule [8], neurologic examination was unremarkable. Neurological signs that have been described in the context of left capsular genu lesions [8–14], e.g. amnesia, aphasia, abulia, apathy, confusion, right hemiparesis, hemiataxia, facial or lingual paresis with dysarthria, clumsy-hand syndrome or pure sensory stroke, were not seen at presentation, neither were other non-focal symptoms such as headache, light-headedness, mood lability, flapping tremor or hiccup, which can be associated with internal capsule infarction [15]. However, as judged by the size of the lacune (Fig. 1), the infarction was not silent [16].

## 2.6. Other diagnostic procedures

Further examination showed that both electroencephalogram and electrocardiogram (including a 24-h Holter monitoring) were



**Fig. 1.** Axial T1-weighted magnetic resonance image showing a hypodense lacunar lesion in the genu and anterior limb of the left internal capsule, involving a portion of the putamen (arrow).

normal. A cardiac ultrasonographic examination revealed normal size and function of the heart. Pulmonary artery pressure was normal. Autoimmune antibodies were not detected.

## 2.7. Neuropsychological testing

As the location of the lacune implied disconnection of the left prefrontal cortex [10], we performed a number of neuropsychological tests with particular emphasis on the assessment of executive function and control [17]. Performance on the Wisconsin Card Sorting Test, which is sensitive to frontal lobe damage [18], was poor (43 of 96 trials correct; 19 perseverative errors). Assessment of letter-based word retrieval using the phonemic version of the Thurstone Word Fluency Test yielded remarkably poor results (23 words produced in 3 min), consistent with a loss-of-function of the left frontal lobe [19]. Performance on the Five-Point Design Fluency Test, which is also sensitive to frontal brain pathology [20], was below the normal range (27 unique designs produced in 5 min). The Rey-Osterrieth Complex Figure Test, which assesses both visual memory and executive functions and which is sensitive to a broad spectrum of brain pathologies, including frontal lobe dysfunction [21], yielded results below the population norm for both the copy (score 22.5 of 36 possible) and the delayed recall condition (score 8.5). The Rey Auditory Verbal Learning Test (RAVLT), which assesses verbal memory and which is sensitive to frontal lobe dysfunction [22], showed poor results in both immediate (4 of 15 words recalled) and delayed recall (5 of 15 words recalled). The most severe loss of memory function, as assessed by the RAVLT, was noted by the effect of a second, so-called distractor list on the retention of previously learned material (1 of 15 words recalled). Alertness as measured by the reaction time to a stimulus (TAP 2.0 software package, Siemens, Bonn, Germany) with (median 289.0 ms) or without tonal warning (299.5 ms) was severely compromised, indicating significant impairment of brain function [23]. Performance on the Trail Making Test A (TMT-A, 36 s) and B (TMT-B, 69 s) was below average, consistent with the observation that this test of attention and executive function is also sensitive to frontal lobe function [24]. The Wechsler Adult Intelligence Scale-III (WAIS-III, Harcourt Test Services, 2006, Frankfurt/Main, Germany) showed scores below the normal range (scaled score  $10 \pm 3$ ) for three performance

subtests, i.e. picture completion (score 6), block design (score 6), and digit symbol-coding (score 3), indicating moderate impairment in perceptual organization and severe impairment in processing speed, consistent with the involvement of frontal brain regions in these tasks [25]. An important finding across all neuropsychological tests was the examinee's unawareness of his test performance. This observation is consistent with descriptions of anosognosia for cognitive functions in patients with frontal lobe dysfunction [26]. Following left frontal lobe damage, anosognosia combined with personal neglect has also been reported [27].

Most likely, these cognitive impairments developed as a result of the lacunar stroke, as two years prior, in the course of a successful inpatient alcohol detoxification treatment, no significant impairments in the Benton Visual Retention Test [17], the TMT or the WAIS-III (all subtest scores within normal range, i.e.  $10 \pm 3$ ) were found. In particular, the three WAIS-III performance subtests with low scores in the post-stroke condition were unremarkable in the pre-stroke condition, i.e. picture completion (score 8), block design (score 7), and digit symbol-coding (score 8). The average premorbid intelligence quotient (IQ) score, obtained at that time, was 95 (performance score 91; verbal score 100).

### 3. Discussion

Arson is frequently associated with psychiatric morbidity and with previous non-violent or violent offences [28]. In contrast, our case suggests an association between an isolated, first-time arson offence and a single lacunar stroke. The precise mechanism that links damage of the left internal capsule to this complex impulse-driven behavior is not known. However, lesions in the genu region of the internal capsule seem to result in disconnection and deactivation of the frontal cortex [10]. Consistent with this are more recent observations, connecting cognitive inflexibility with prefrontal depletion of serotonin [29], a neurotransmitter synthesized in the brain stem and transported along neural projections through the internal capsule before reaching frontal lobe structures [7]. Moreover and in agreement with our findings, neuropsychological deficits, including memory impairment, have been associated with left internal capsule infarction [8,10]. Frontal lobe syndrome after infarction of the left internal capsule has also been reported [30]. Finally, a neural framework controlling impulsive behavior, decision-making and willpower has been proposed with components of this framework primarily localized to frontal lobe structures [31].

Here, we argue that, in our case, disconnection of the left frontal lobe resulted in impairments of cognition, primarily executive functions, involving planning and judgment, as well as in partial loss of memory and impulse control functions, which, together, led to a bizarre type of impulse-driven, non-intentional fire-setting behavior. Consequently, the examinee's capacity to form a specific intent at the time of the offence remained uncertain, implying lack of capacity to form *mens rea* [32], which, at least in part, negated criminal responsibility.

Based on our pre-trial evaluation, a diagnosis of personality change (disinhibited behavior) due to brain damage and dysfunction (DSM IV-TR: 310.1) was made, combined with anosognostic features, i.e. the suspect's unawareness of his impaired cognitive functions. The examinee was found not criminally responsible. However, the examinee was deemed at risk for criminal recidivism as no specific treatment for his condition existed. We recommended continuing prophylactic treatment with acetylsalicylate to help prevent further hypoxic-ischemic insults. The case was closed with a verdict of not guilty by reason of legal insanity and the examinee was transferred to a supervised facility. Neuropsychological reassessment may help estimate the examinee's risk for future criminal recidivism.

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